

**AN IMPROVED METHODOLOGY FOR SCREENING
MILITARY PILOT APPLICANTS**

A thesis presented to the Faculty of the U. S. Army
Command and General Staff College in partial
fulfillment of the requirements of the
degree

MASTER OF MILITARY ART AND SCIENCE

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The opinions and conclusions expressed herein are those of the individual student author and do not necessarily represent the views of either the U. S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

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by
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ABSTRACT

This thesis concentrates on the process of selecting men for military pilot training. Past, present and possible future selection techniques are explored and analyzed. The objective is to determine how the present selection method can be improved so that the number of eliminations from pilot training, and, consequently, the cost of military pilot training may be reduced. The paper is divided into three general areas:

History and Analysis of Selection Methods

The methods which have been used to select men for military pilot training from 1908 to 1966 are reviewed and analyzed. Written and apparatus aptitude tests which were developed during World War II receive detailed analysis.

Investigation of Other Applicable Procedures

Several procedures are explored which might improve the selection system if implemented. These include light plane training; the Flight Instruction Program; personal interviews; psychological, psychiatric, stress and motivation testing.

Conclusions

Four conclusions are evolved from investigation and analysis:

- a. The written aptitude test should be retained.
- b. Flight Instruction Program screening should be expanded to include applicants for pilot training from the U. S. Air Force Officer Training School and U. S. Navy Aviation Officer Candidate sources.

c. A modern apparatus test should be developed and included in selection testing to evaluate pilot potential.

d. A valid motivation test should be developed and implemented for inclusion in the battery of selection tests.

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INTRODUCTION

Nearly one out of every five men who enter military pilot training today are eliminated before graduation even though special pretraining selection techniques are employed to screen-out individuals lacking pilot potential. This elimination rate indicates that reliable procedures have not been developed, or are not being used.

Eliminated students represent a considerable waste of instructor time, training facilities, and money. Each U. S. Air Force graduate from pilot training currently represents a national investment of \$86,030, in addition to the cost of the training aircraft.¹ Based on the current rate of elimination, and the average length of training before elimination, it is estimated that the U. S. Air Force will spend approximately \$23 million on students who entered training, but who will not graduate, with the fiscal year 1966 classes. When the cost of non-productive U. S. Army and U. S. Naval aviation training is included, the annual national loss is of still greater significance. As higher performance aircraft become operational in all services, pilot training will become commensurately more costly, and it is reasonable to assume that the future cost of non-productive pilot training will continue to increase unless steps are taken soon to reduce the current rate of elimination.

¹Unpublished personal interview with Mr. C. Niblock, Office of DCS Comptroller, HQ., Air Training Command, Randolph AFB, Texas.
25 Jan 66.

An elimination rate of from three-to-five per cent of the entries would allow for medical and other unpredictable attritions which occur in any group during a lengthy training program. Students need not be eliminated for fear of flying, flying deficiency, or self-initiated elimination if the methods of selecting men for pilot training are sufficiently refined. This paper purports to have developed such a method which, if applied, will assist responsible officials in improving pilot-trainee selection procedures and reduce the waste of time, manpower and money resulting from the current high rate of elimination.

This project has been conducted in three phases:

a. The methods that have been, and are being used to select men for military pilot training are reviewed. The effectiveness of these methods, as determined by the capability of the method to predict success or failure in pilot training, are analyzed.

b. Procedures which will improve the predictability of tests, if incorporated into the method of selection for pilot training, are examined.

c. Conclusions which will make it possible to improve the current method of selecting pilot trainees, and, consequently, reduce the eliminations from pilot training, without affecting the number or quality of graduates, are presented.

Research and recommendations have been oriented on development of a plan designed to affect an improvement within the present selection framework. The relation between the number of applicants who are screened for pilot training and the number of pilots graduated need not change. Conclusions are directed toward preventing initial

selection of more of those who would ultimately be eliminated from pilot training. Routine prerequisites of age, education, military or medical status will not be discussed. This study is devoted strictly to that part of the pilot selection process which is used to estimate an applicant's pilot potential.

CHAPTER I

PILOT SELECTION BEFORE WORLD WAR II

The employment of aviation by United States military forces began when the Aeronautical Division of the U. S. Army Signal Corps was established in 1908.¹ By 1938 the U. S. Army Air Corps had grown slowly from its original three, to 1,506 aviation officers.² This chapter will review the methods used by the U. S. Army to select men for pilot training from 1908 through 1941.

The military was slow to recognize the fact that piloting an airplane might require unique individual capabilities. One historian states that during the early part of World War I, the Allies selected their pilots rather haphazardly. Courage was considered the only trait essential for piloting an airplane, and if an individual

¹"Legislation Relating to the Air Corps Personnel and Training Programs: 1908 to 1939," Army Air Forces Historical Studies No. 39 (Washington, D. C.: Army Air Forces Historical Division, 1945), p. 2.

²Stanines: Selection and Classification for Air Crew Duty (Washington, D. C.: HQ., Army Air Forces, 1946), p. 1.

possessed that characteristic to a high degree, there was nothing to prevent him from flying.³ During the first year of World War I:

The British . . . found that of every 100 aviators killed, two met death at the hands of the enemy, eight because of defective planes, and the remaining ninety because of their own individual deficiencies . . .⁴

The accuracy of World War I accident investigation techniques may be questioned; however, the need for a more effective system of obtaining pilots was obvious. Following World War I, the U. S. Army developed a procedure for selecting men for pilot training based on prerequisites of age (20-27), physical condition, and education, in conjunction with a flight surgeon's interview and a competitive written examination. Specific requirements varied from time to time, but this basic method of selection lasted until World War II. The written examination was educationally oriented, and failure was common for those without an academic background.⁵ For sixteen years preceding World War II, only twenty-two per cent of the 37,000 pilot applicants passed the written examination.⁶

A measure of education, therefore, was the primary tool used for selecting men for pilot training between the two World Wars.

³"Initial Selection of Candidates for Pilot, Bombardier, and Navigator Training," Army Air Forces Historical Studies No. 2 (Washington, D. C.: Army Air Forces Historical Division, 1943), p. 1. Cited hereafter as Historical Study no. 2.

⁴Ibid.

⁵C. L. Grant, Policies and Procedures Governing Elimination From AAF Schools 1939-1945 (Maxwell AFB, Alabama: U. S. Air Force Historical Division, Air University, 1952), p. 1.

⁶Historical Study no. 2, p. 6.

In essence, this method was a process of "natural" selection. The individuals who were motivated for aviation training enough to compete for the small number of peace-time pilot training quotas, and who were educationally and otherwise qualified, were already a highly select group. By selecting less than one-fourth of those applicants through competitive examinations, the U. S. Army was getting the "best-of-the-best" available. It is interesting to note, however, that during this period nearly fifty per cent of the selectees were being eliminated from pilot training.⁷

Some attempts were made to reduce the number of eliminees by better selection devices. In 1926, experiments in psychological testing were conducted by the School of Aviation Medicine. During the 1930's, the Training Division of the U. S. Army Air Corps was also conducting research on the problem. Dr. C. L. Grant, who prepared the Policies and Procedures Governing Elimination from AAF Schools: 1939-1945, states that even though the School of Aviation Medicine's work was productive,

the results were not utilized to the fullest extent possible--probably because there was no pressing demand for flyers. Since the Air Corps could always turn out as many flyers as it needed, it could afford to avoid the nuisance of efficient selection.⁸

In 1939, President Franklin D. Roosevelt emphasized the need for a large Air Corps to meet the critical situation in Europe and the Far East. Congress responded by authorizing an expanded pilot training program which called for training 1,200 pilots annually

⁷Grant, p. 3.

⁸Ibid.

beginning in July 1939. By May of 1940, this plan had been superseded, and the production goal raised to 7,000 annually, a goal ultimately enlarged to a requirement for 70,000 pilots a year. The resulting rapid increase in the number of men applying for pilot training quickly overloaded the existing selection system. The magnitude of this increase can be appreciated when we find that from 1923 to 1939 the U. S. Army Air Corps had been allowed to produce only 3,505 pilots--an average of 219 a year.⁹

Many individuals who desired pilot training lacked college education and were unable to pass the written examination. Individuals and organizations, in a patriotic effort to assist these men in preparing for flight training, established "prep schools." The American Legion, for example, urged colleges throughout the country to give support to the U. S. Army Air Corps by inaugurating "prep schools" which would prepare applicants for the educational examination. The response was unusually favorable, and during the fall of 1941 many such schools were established.¹⁰ Because the written examination was academically oriented, "prepping" had a predictable effect. During the last half of 1941, twice as many applicants successfully passed the examination.¹¹

Paradoxically, research conducted after World War II revealed that the amount of formal education was apparently unrelated to success

⁹Ibid., p. 1.

¹⁰"Procurement of Aircrrew Trainees," Army Air Forces Historical Studies no. 15 (Washington, D. C.: Army Air Forces Historical Division, 1944), pp. 13-14.

¹¹Ibid., p. 16.

in pilot training.¹² As late as 1940, there was no test in the selection system which attempted, specifically, to measure pilot potential. With the exception of the physical prerequisite, therefore, selection of men for pilot training in 1940 was little more effective than it was in 1908.

SUMMARY

The air arm of the United States military forces grew slowly from its inception in 1908 until 1940, when the build-up for World War II began. During this period the number of men desiring pilot training exceeded by a considerable number the small annual requirement for new pilots. As early as 1926, attempts were made to develop a selection system using psychological testing. However, the results were not fully utilized, presumably because there was no pressing need for efficient selection.

Between World Wars I and II the U. S. Army Air Corps relied on a selection system based on specific prerequisites of age, physical condition and education in conjunction with a flight surgeon's interview and a competitive written examination. The written examination was academically oriented, and applicants without college educations had considerable difficulty in passing it. The written examination was the primary device for selecting the "top" applicants. Eliminations from pilot training during this period remained relatively high--nearly fifty per cent failed to complete pilot training.

¹²Raymond E. Christal and John D. Krumbolts, Use of the Air Force Officer Qualification Test in the AFROTC Selection Program (Lackland AFB, Texas: Air Force Personnel and Training Center, 1957), p. 7.

Tests conducted after World War II revealed that formal education is a poor predictor of success in pilot training. The U. S. Army Air Corps, with primary reliance on an education-oriented examination for selecting pilot trainees, approached World War II without an effective method for determining pilot potential.

CHAPTER II

HISTORY AND ANALYSIS OF THE CURRENT SELECTION METHOD

The preceding chapter discussed early methods of selecting men for pilot training. This chapter will review the development, and analyze the effectiveness, of the current method of selecting men for military pilot training.

Written Tests

The tests currently being used to select applicants for pilot training can be traced to the work of the Army Air Corps' Psychological Research Agency (PRA).¹ The PRA was established in June 1941 with the mission to devise a method for predicting success or failure of prospective pilot trainees, in order to reduce eliminations from flying training.² In view of the volume testing which was required to support the World War II buildup, the PRA decided that the first requirement

¹"Initial Selection of Candidates for Pilot, Bombardier, and Navigator Training," Army Air Forces Historical Studies No. 2 (Washington D. C.: HQ., Army Air Forces, 1943), p. 24. Cited hereafter as AAF Historical Study no. 2.

²C. L. Grant, Policies and Procedures Governing Elimination from AAF Schools: 1939-1945 (Maxwell AFB, Alabama: U. S. Air Force Historical Division, Air University, 1952), p. 1.

was to develop a test which could be administered by examining boards throughout the country to any applicant who wanted to enlist as an aviation cadet.³ This represented a fundamental change from the prewar approach which required a flight surgeon interview and an educational examination, before being eligible to apply for aviation cadet training. It was the first step toward basing eligibility for pilot training on aptitude, rather than education.

The first PRA product, therefore, was an Aviation Cadet Qualifying Examination (ACQE), prepared in January 1942.⁴ This was a written screening test designed for preliminary selection of men to be trained as aircrew, and was administered by aviation cadet examining boards throughout the United States.

The second product was the AircREW Classification Battery (ACB) completed in February 1942.⁵ This was an eight hour battery of written and apparatus tests, which determined predictive scores for classification into one of three aircrew specialties: Pilot, Bombardier and navigator. Men who were selected for aircrew training, on the basis of ACQE test, took the ACB test at one of three Psychological Research Units established at classification centers in Nashville, Tennessee; San Antonio, Texas; and Santa Ana, California.

Development of the ACB will be discussed hereafter with regard to selection for pilot training. Bombardier and navigator classification,

³AAF Historical Study no. 2, p. 1.

⁴Ibid., p. 25.

⁵Lonnie D. Valentine, Jr. and John A. Creager, Officer Selection and Classification Tests: Their Development and Use (Lackland AFB, Texas: Personnel Laboratory, Aeronautical Systems Division, 1961), p. 1.

although accomplished by the same ACB, will not be included in the discussion. The apparatus testing portion of the ACB will be discussed later in this chapter.

Development of the ACB tests began with a survey of difficulties encountered in learning to fly and an analysis of the reasons for "washing out." The PRA research group developed a list of twenty psychological assets for success in flight training, and then developed tests to measure these psychological traits. Tests were sub-divided into areas measuring judgment, mechanical aptitude, instrument and dial reading capability, general knowledge, ability to visualize plane movements, special orientation, personal history and attitudes.⁶ Experimental ACBs were administered to all available cadets before entering flight training. Upon graduation test results were compared with training records. If high scores related to success in training and low scores to elimination, the test was retained. Poor predictors were discarded. The process of research, test development and construction was continuous. New and better tests were added to the original battery and substitutes were made for those tests proven to be less effective.⁷

The predictive score determined by the ACB became known as the "stanine", which is an acronym of "standard nine." Aptitude scores were designed as standard scores with a mean five, and a range from

⁶Eliot Tozer, "Taking the Guesswork out of Pilot Selection," Aviation Age, (23 March 1955), p. 149.

⁷Stanines: Selection and Classification for Air Crew Duty (Washington, D. C.: HQ., Army Air Forces, 1946), p. 16. Cited hereafter as Stanines.

one to nine.⁸ Table 1 relates the stanine score distribution to an average test group.⁹

TABLE 1

U. S. ARMY AIR FORCE STANINE SCORES

Stanine	Per Cent Who Will Obtain Each Stanine
9	4
8	7
7	12
6	17
5 (mean).....	20
4	17
3	12
2	7
1	4

The classification program changed considerably during the course of the war. As the ACB was shown to be a reliable predictor of later success, it began to be used for selection of pilots as well as for aircrew classification. Minimum qualifying standards, in terms of stanine score, were adopted and changed from time to time to meet the requirements of training and combat units. The first "cut off" (at stanine three) was established 1 Dec 1942. By 24 Oct 1944, the minimum

⁸Army Air Forces Psychology Program Research Report No. 2, ed. Philip H. De Bois (Washington, D. C.: HQ., U. S. Army, 1947), p. 21. Cited hereafter as AAF Report no. 2.

⁹Ibid., p. 85.

qualifying stanine score for entry into pilot training had been raised to seven. This resulted in a seventy-seven per cent rejection of applicants.¹⁰ Although beneficial in terms of reducing eliminations from pilot training, excluding applicants with low stanine scores made it impossible for researchers to get records of performance in training for the individual who had already been eliminated by these tests.

In order to validate tests and aptitude scores, it was decided to get empirical data on the training performance of a random group of individuals who had not been selected by test performance. An experiment was authorized by the U. S. Army Air Force and from August through October 1943, 1,311 individuals were recruited. All men were tested using the standard ACQE and ACB and were accepted for flying training irrespective of their test score. These men entered directly into pilot preflight training, and followed the usual course through primary, basic, and advanced training. They were distributed through many classes and flight schools and were given normal training, mixed with trainees who had been screened and selected by standard procedures. The effectiveness of the stanine score as a method for predicting trainee success was proven by the results of this experiment. Out of the 150 men with pilot stanines of one, not a single man was graduated from advanced flying training. Only sixteen out of 291 men with stanines of two or three were graduated. In contrast, of ninety-eight men with pilot stanines of eight or nine,

¹⁰Army Air Forces Psychology Program Research Report No. 4, ed. Arthur W. Melton (Washington, D. C.: HQ., U. S. Army, 1947), p. 75. Cited hereafter as AAF Report no. 4.

only fifteen were eliminated.¹¹ This experiment proved conclusively the validity of the ACB pilot stanine score. Table 2 shows the per cent eliminees in the experimental group for each stanine score.¹²

TABLE 2

COMPARISON OF EXPERIMENTAL GROUP STANINE SCORE
AND SUCCESS IN PILOT TRAINING

Stanine Score	Per Cent Eliminated
9	23.9
8	22.5
7	44.4
6	51.5
5	70.8
4	72.3
3	93.4
2	92.5
1	100.0

ACB pilot stanine scores and success in pilot training correlated quite well, as would be expected, with the results of the experimental group. An analysis of stanine scores and graduates from pilot training classes 44-G through 45-D (graduated in 1944) showed a similar correlation. Fourteen per cent of the stanine score "nines" were eliminated, as compared with eighty-one per cent of the stanine score "ones." Table 3 shows the relation of eliminations to each stanine score.¹³

¹¹AAF Report no. 2, pp. 181-201. ¹²Ibid., p. 208.

¹³AAF Report no. 2, p. 145.

TABLE 3

RELATION OF THE AIRCREW CLASSIFICATION BATTERY
 PILOT STANINE SCORE AND SUCCESS IN
 PRIMARY THROUGH ADVANCED
 PILOT TRAINING

Pilot Stanine	No. of Men	Per Cent Eliminated ^a In Pilot Training
9	8,076	14
8	6,251	24
7	10,676	31
6	12,905	43
5	8,219	52
4	4,137	61
3	139	73
2	127	76
1	67	81
	<u>50,597</u>	36.6% Average Elimination

^aEliminated for flying deficiency, fear of flying and by their own request, from classes 44-G through 45-D.

Education had been the foundation of the selection procedure before the ACB was developed. The ACB was designed to determine pilot aptitude, independent of other factors. An analysis of aviation cadet and student officer performance in the 1953-54 pilot training classes vindicated the ACB approach. The elimination rate of individuals with twelve years of education did not vary significantly from men with post-graduate professional training--twenty-four and twenty-six per cent, respectively.¹⁴ This would apparently indicate that formal education is unrelated to success in pilot training. Table 4 shows the relationship between formal education and success in primary pilot training.

TABLE 4
RELATIONSHIP BETWEEN FORMAL EDUCATION AND
SUCCESS IN PRIMARY PILOT TRAINING

Education	Number	Per Cent Eliminated
Professional school	84	26
4 years college	1,670	27
3 years college	1,170	26
2 years college	2,446	24
1 year college	1,094	22
12 years education	2,968	24
11 years education	21	19

¹⁴Raymond E. Christal and John D. Krumboltz, Use of the Air Force Officer Qualification Test in the AFROTC Selection Program (Lackland AFB, Texas: Air Force Personnel and Training Center, 1957), p. 7.

While pilot aptitude tests were developed exclusively for selecting men for entry into pilot training, it is interesting to note the post-training correlations reported in two studies conducted by the Fourth Air Force. One study, of 1,880 P-38 pilots, concluded that the lower the pilot's stanine scores, the greater the chances that he would have one or more accidents, and that these accidents would be due to pilot error.¹⁵ A similar study, of B-24 crews, indicated that men with high pilot stanine scores were more likely to become aircraft commanders, while men with low scores would be assigned as co-pilots.¹⁶ These results attest to the ability of the ACB test to determine aptitude for flying in general, not just aptitude for succeeding in flying training.

By 1946, the ACB had been administered to approximately 650,000 aviation cadets.¹⁷ Continued research and analysis by a large staff of aviation psychologists had transformed a collection of printed tests, about which little was known, into a well-validated scientifically based evaluator. The psychological testing program was curtailed at the end of World War II, and the few remaining PRA personnel concentrated on completing a nineteen volume series of research reports covering the test program.¹⁸ The ACB was retained by the U. S. Army and, subsequently, the U. S. Air Force, until July 1955, at which time it was replaced by the Air Force Officer Qualifying Test (AFOQT).

The AFOQT was a written test only, which, essentially, combined the written pilot and observer aptitude portion of the ACB with other

¹⁵ Human Factors in Aircraft Accidents (Norton AFB, California: Deputy Inspector General for Technical Inspection and Flight Safety Research, 1950), p. 7.

¹⁶ Stanines, p. 48. ¹⁷ Ibid., p. 2. ¹⁸ Valentine, p. 2.

sub-tests designed to measure officer potential. Apparatus testing, which will be discussed later, was discontinued, along with the ACB. Development of the AFOQT began in 1949, and it was well validated before being implemented as a new test to select men for pilot training. Its validity in determining pilot aptitude was demonstrated by comparing results of pilot stanine scores from the first operational AFOQT and success in primary pilot training. Only two per cent of the stanine score "nines" were eliminated as compared to sixty-seven per cent of the stanine "ones". Table 5 compares eliminations and all stanine scores.

TABLE 5
EFFECTIVENESS OF 1955 AFOQT PILOT STANINE SCORE
FOR PREDICTING SUCCESS OF AFROTC GRADUATES
IN PRIMARY PILOT TRAINING

Pilot Stanine	Per Cent Eliminees
9	2
8	7
7	12
6	15
5	23
4	33
3	39
2	57
1	67

In 1961 the scoring reference was changed. The now famous stanine score gave way to the more definitive percentile score. Table 6 compares the two scores for future reference.¹⁹

TABLE 6
COMPARISON OF STANINE SCORE TO PERCENTILE
SCORE FOR AFOQT

Stanine Score	Percentile Score
9	95
8	90
	85
7	80
	75
	70
	65
6	60
	55
	50
	45
5	40
	35
	30
4	25
	20
3	15
2	10
1	5

AFOQT tests have evolved through a process of validation and revision in much the same manner as the written portion of the ACB evolved during World War II. The most recent series, AFOQT-64, was introduced in September 1963. AFOQT-64 is shorter than previous series. It contains a total of 542 items and requires slightly under six hours

¹⁹U. S. Air Force Manual No. 35-8, Air Force Military Personnel Testing Manual (Washington, D. C.: Department of the Air Force, 1962), p. 24.

to administer.²⁰ Table 7 shows the sub-test components of each of the five operational aptitude composites for which percentile scores are determined: Pilot, Navigator-Technical, Officer Quality, Verbal, and Quantitative. Approximately forty per cent of the test items (210 of 542) are used to determine the pilot aptitude percentile score.

²⁰ Robert E. Miller and Lonnie D. Valentine, Jr., Development and Standardization of the Air Force Officer Qualifying Test-64 (Lackland AFB, Texas: 6570th Personnel Research Laboratory, 1964), pp. 1-3.

TABLE 7
CONTENT OF AIR FORCE OFFICERS QUALIFYING TEST-64

Subtests	No. of Items	Pa	NT	OQ	V	Q	A ^b	CP
oklet 1 Quantitative Aptitude	60			X	X	X	X	
oklet 2 Verbal Aptitude	60			X	X		X	
Officer Biographical Inventory	100			X				X
oklet 3 Scale Reading	48			X				
Aerial Landmarks	40			X				
General Science	24			X				
oklet 4 Mechanical Information	24	X		X				
Mechanical Principles	24	X		X				
oklet 5 Pilot Biographical Inventory	50		X					
Aviation Information	24		X					
Visualization of Maneuvers	24		X					
Instrument Comprehension	24		X					
Flight Orientation	40		X					
Total	542							

^aP=Pilot, NT=Nav-Tech, OQ=Officer Quality, V=Verbal, Q=Quantitative, A=Academic,
=Career Potential.

^bComposites Academic and Career Potential are used only for the AFROTC Officer Education Program.

^cSpeeded Subtests.

A logical question at this point is how does the AFOQT compare with its ACB predecessors? A correlation coefficient between the AFOQT-64 pilot aptitude score and success in undergraduate pilot training was computed for all students who received training in T-38 aircraft in classes 63A through 65B (graduated last half 1962 through first half 1964). Data on the complete applicant group is not obtainable since not all applicants were selected for pilot training. By applying a correction for this range restriction, however, it is possible to estimate correlations for the entire applicant group. This procedure would make the correlation coefficient directly comparable to the correlation coefficient determined for the 1943 experimental group discussed earlier. The AFOQT-64 pilot aptitude score correlation coefficient compared with success in pilot training is 0.30, as compared with 0.66 for the 1943 experimental group.²¹ As a basis for estimating the relative effectiveness of the AFOQT and the ACB, a correlation coefficient of 1.0 would indicate perfect correlation between pilot stanine score and graduation or elimination from pilot training. A coefficient of 0.0 would indicate no correlation, at all. This indicates that the pilot aptitude score being determined by the AFOQT today, therefore, is not as accurate as the ACB pilot stanine of World War II for predicting success in pilot training.

The AFOQT is the only qualifying examination administered by the U. S. Air Force to establish officer, pilot, and navigator-technical aptitude. Conversely stated, a written pilot aptitude

²¹Unpublished information provided by Dr. Robert E. Miller, Research Psychologist, HQ., 6570th Personnel Research Laboratory, Lackland AFB, Texas. 3 Feb 66.

examination is the only measure employed by the U. S. Air Force to select pilot trainees from applicants who were otherwise qualified.²² The selection process for U. S. Army Aviation training and U. S. Naval Aviation training is similar.

The U. S. Army's first post-World War II test, the Army Fixed-Wing Aptitude Battery-one (AFWAB-1), implemented in August 1958, was an adaptation of the U. S. Air Force test.²³ Follow-up validation studies resulted in AFWAB-2 which was more suitable for Army aviation. AFWAB-2 is a written test which is administered in one hour and forty minutes. Sub-tests include Aviation Information, Mechanical Information, Mechanical Principles, Biographical Information, Visualization of Maneuvers, Instrument Comprehension, and a Flight Orientation Test.²⁴ Reference to Table 7 will show that these seven sub-tests correspond almost exactly to the seven sub-tests of the AFOQT which determine pilot aptitude for the U. S. Air Force. Selection for helicopter pilot training posed unique problems. The U. S. Army, therefore, developed and implemented the Army Rotary Wing Aptitude Battery-one (ARWAB-1) in October 1961. This test requires approximately one hour and ten minutes to complete and consists of four sub-tests; Locations, Helicopter Information, Complex Movements, and the Helicopter Pilot

²²U. S. Air Force Regulation 51-4, Flying Training in Officer Grade (Washington, D. C.: Department of the Air Force, 1962), pp. 1-2.

²³Human Factors Research & Development: Tenth Annual Conference (Washington, D. C.: Office of the Chief of Research and Development, HQ., U. S. Army, 1964), p. 278.

²⁴Unpublished personal interview with Mrs. Chapman, Test Examiner, 304th Test Control Office, Ft. Leavenworth, Kansas. 26 Jan 66. Cited hereafter as Chapman.

Self-Description Test.²⁵ The Army Personnel Research Office is currently developing a composite four-battery test which will integrate fixed and rotary wing testing and will replace the AFWAB and ARWAB.

The U. S. Navy administers a two-test series. The first test--the Aviation Qualification Test (AQT)--is designed to predict ground school performance. Pilot aptitude is determined by a separate three part examination sub-sectioned into Mechanical Comprehension, Spatial Apperception, and Biographical Inventory. Total testing time is approximately two and one-half hours. Sub-test results are combined into a Flight Aptitude Rating (FAR) score which is used to determine eligibility for pilot training.²⁶

There is considerable similarity between the flight selection tests used by all three services. All tests are written, and all are designed to determine pilot aptitude. Although written tests are now used exclusively to determine pilot aptitude, apparatus tests were used during World War II in conjunction with written tests.

Apparatus Tests

Apparatus tests were developed in much the same manner as the written tests described above. The U. S. Army Air Corps School of Aviation Medicine (SAM) was responsible for design and production of apparatus test units. Development was coordinated closely with the PRA to insure integration of the entire testing program.²⁷

²⁵Chapman.

²⁶The Aviation Selection Tests (N. A. S. Pensacola, Florida: U. S. Naval Aviation Medical Center, Rev. 2/1965), pp. 1-2.

²⁷AAF Report no. 4, p. 2.

Some apparatus testing had been conducted before World War II, however, it was primarily experimental and the SAM possessed very little equipment. Apparatus had to be borrowed from colleges and universities so that validation testing could begin.²⁸ Apparatus tests were developed by revising existing tests or designing new ones. The philosophy behind the development of apparatus tests, was to design tests which would complement the written tests. The rationale which guided research psychologists was stated as follows:

... the development and use of apparatus tests was predicated upon the conviction that there were certain mental functions or abilities which could only be measured, or at least could best be measured, by performance tests, as contrasted with paper-and-pencil tests. At no time was there the intention of measuring with apparatus some function which could be measured as meaningfully by the marking of an ... answer sheet.²⁹

The first test battery, consisting of five fifteen minute apparatus tests, was used initially in August 1942. This apparatus battery, in conjunction with the written tests discussed above, constituted the ACB. The apparatus and written results were combined to determine a pilot aptitude stanine score.³⁰ As in the case of the written tests, the apparatus tests were revised as data was obtained. Poor predictors were deleted, new tests were added and relative weights were changed throughout the testing program. Apparatus tests used for determining pilot aptitude ranged from a maximum of six in December 1942 to a minimum of three in 1945; ten different tests were used altogether. The apparatus test contributed from twenty-six to fifty-seven per cent of the pilot aptitude stanine score. Table 8 shows the tests used and their relative weight by test series from 1942 through 1945.³¹

²⁸Ibid., p. 1. ²⁹Ibid., p. 54. ³⁰Ibid., p. 6. ³¹Ibid.

TABLE 8

APPARATUS TESTS USED IN THE AIRCREW CLASSIFICATION
 BATTERIES AND EFFECTIVE WEIGHT OF SCORE OBTAINED

Test	Aug 1942	Dec 1942	Jul 1943	Nov 1943	Sep 1944	Jun 1945		
	p ^a	P	P	P	bP	fP	bP	fP
Complex Coordination	17	18	20	17	10	13	10	13
Two-Hand Coordination	17	11	12	4	0	7		
Two-Hand Pursuit							0	7
Discrimination Reaction Time	5	15	3	4	0	10	0	9
finger Dexterity	1	1						
Tiredness Under Pressure	5							
Enduring Stress		8	6					
Memory Pursuit		9						
Memory Pursuit with Divided Attention			16	4	8	0	8	0
Under Control				12	8	17	8	18
Total Test Weight								
Apparatus	45	52	57	41	26	47	26	47
Written	59	49	42	59	74	53	75	55

^aP=Pilot, bP=Bomber Pilot, fP=Fighter Pilot.

In order to understand the type of apparatus tests used, five of the tests which formed the basic framework of the testing program are described briefly:

Complex Coordination Test.

All models of the School of Aviation Medicine Complex Coordination Test and its forbears have in common the intent to measure the ability of individuals to make successive coordinated movements of an airplane-type stick and rudder in response to successively presented patterns of visual signals. In all classification models the candidate is confronted with three double rows of lamps in which one row of each pair (the response row) has green lamps. When a pattern of signals, composed of one red light in each signal row occurs, the candidate must make appropriate movements of the stick and rudder to light the corresponding green lamps in the response rows. After this matching has been held for a short period of time, usually 0.5 second, a new pattern of signal lights is presented and the candidate must move the stick and rudder until the response lamps corresponding to these new signal lamps are lighted. The score may be either the number of signal patterns correctly matched in a fixed period of time, as was the case in the classification use of the test, or the amount of time required to complete a fixed number of signal patterns, as was the case in the prewar use of the test at the AAF School of Aviation Medicine.³²

Two-Hand Coordination Test.

The School of Aviation Medicine Two-Hand Coordination Test was designed to measure a candidate's ability to coordinate the movement of both hands to control the movements of a target-follower in response to a visually perceived target moving at varying rates along an irregular pathway. Rotation of the upper handle causes a contact point, which is mounted on the leaf of a microswitch, to move toward the candidate with counterclockwise rotation and away from the candidate with clockwise rotation. Rotation of the lower handle in a counterclockwise and clockwise direction caused the contact point to move in any desired direction in the plane of movement of the target. A candidate's task is to manipulate the controls in such a way as to keep the target-follower on top of a round brass button (the target) as it moves along an irregular clockwise path. When the contact point is on the target button the microswitch is closed and current flows to an electric clock located on a remote control desk. The time which is accumulated on the clock during a series of eight 1-minute trials indicates the efficiency of the candidate's performance.³³

³²Ibid., pp. 79-80. ³³Ibid., pp. 179-80.

Discrimination Reaction Time.

The School of Aviation Medicine Discrimination Reaction Time Test was designed to measure the speed with which individuals make differential manual responses to visual stimulus patterns differing from one another with respect to the spatial arrangement of their component parts. The test requires that the candidate react by pushing one of four toggle switches in response to the lighting of a red and a green signal lamp. The position of the red lamp with respect to the green determines which of the four switches is correct. The time taken to operate the correct switch on each of a series of test trials is accumulated on an electric stop clock and constitutes the candidate's score.³⁴

Rotary Pursuit with Divided Attention.

In the School of Aviation Medicine (SAM) Rotary Pursuit Test the candidate's task is to manipulate a stylus in such a manner as to maintain contact between the point of the stylus and a round metal target flush with the surface of a rotating bakelite disc. The efficiency of his performance is determined by recording the time during which he maintains contact between the stylus and the target. As long as the stylus touches the target, a circuit is completed which causes an electric clock to run. When the test is administered with the divided-attention attachment, the candidate is required to make differential manual response to a pair of signal lamps with one hand while manipulating the stylus with the other. Under these conditions, the scoring time is accumulated on the clock only when the stylus is on the target and the correct reaction is being made to the signal lamps.

The SAM divided-attention attachment used in connection with the SAM Rotary Pursuit Test does not constitute a test in itself. It consists of a visual-spatial discrimination attachment which is located beside the Rotary Pursuit Test, and a cycling unit located under the test table. The attachment is an oblong metal box on which two lamps and two spring-return push-button switches are mounted. It is connected electrically to its cycling unit by means of a multiple conductor cable. While following the target with the stylus held in his preferred hand, the candidate must use his other hand to depress the push button which corresponds to the lighted one of the two lamps. These lamps light alternately at various intervals during the course of a Rotary Pursuit Test trial, and unless the proper push-button is held down, no score can be obtained on the Rotary Pursuit Test.³⁵

³⁴Ibid., pp. 262-3. ³⁵Ibid., pp. 331-42.

Rudder Control Test

In this apparatus the subject is seated in a chair mounted on a beam so as to be in an unstable equilibrium. The apparatus is provided with simulated rudder pedals which, when operated, apply tension to springs appropriately placed to bring the apparatus back to a center position. By varying the spring tension on the two sides of the center beam the tension on the two sides of the center beam the candidate can keep the beam balanced in a central position. The task set for the candidate is to keep the beam centered so that a sighting bar mounted on the "fuselage" in front of him is pointed at the center of a target. The number and length of trials given on the test varied from time to time during its use in the classification program, as did the timing mechanism employed. But the score of the candidate throughout was the amount of time that he could keep the fuselage within 2.5 degrees on either side of the center point of the target.³⁶

The scores obtained from individual apparatus tests predicted success in pilot training quite accurately. The fact that a fifteen minute apparatus test appears to be nearly as accurate as a six hour written battery is indeed surprising. Cadets who scored pilot stanines of "nine" on the Complex Coordination Test were eliminated at the rate of 7.6 per cent. Eliminations increased in inverse proportions to the stanine score with stanine scores of "one" being eliminated at the rate of 48.6 per cent. Table 9 shows the per cent of eliminations for all stanine scores.³⁷ A comparison of Tables 3 and 9 will indicate the direct relationship between the accuracy of the overall ACB pilot stanine score and a pilot stanine score determined by the Complex Coordination Test alone. The validity of other apparatus tests, which were retained, was comparable to that of the Complex Coordination Test.

³⁶ Ibid., pp. 402-3. ³⁷ Ibid., p. 139.

TABLE 9

COMPARISON OF SCORES ON THE COMPLEX COORDINATION TEST
AND PER CENT OF ELIMINATION FROM
PILOT TRAINING

Stanine Score		Per Cent
9	.....	7.6
8	.....	10.1
7	.....	13.4
6	.....	15.7
5	.....	23.0
4	.....	28.7
3	.....	36.2
2	.....	43.9
1	.....	48.6

Researchers learned early in the test program that administering apparatus tests posed several problems not encountered with printed tests. Test examiners, for example, required some training in the administration of the tests. Examination results were found to vary in tests where the examiner presented the stimuli and controlled the timing of trials. In other words, the examiner could influence test results. Most of this variation was eliminated by developing automatic control and cycling units for the apparatus; however, some examiner differences remained. It was concluded that this was due to the manner in which instructions and demonstrations were given. To overcome this

problem and to insure standardization among all testing units, very detailed examiner instruction were developed by the SAM Department of Psychology. To illustrate the precision necessary to correctly instruct candidates, a portion of instruction for the Complex Coordination Test is quoted. Detailed examiner instructions are in parentheses:

(Before the candidates enter the room one apparatus is set on pattern No. 19 and the others should be set on pattern No. 20. Stimulus lamps are lighted. When candidates enter they take positions around the demonstration apparatus in which examiner seats himself.)

This is a coordination test. Your task will be to line up a green light with each of the three red lights. Moving the stick from side to side (move stick slowly, to get perceptual discreetness in the lighting of lamps, from extreme right to extreme left and back to neutral) moves the top green light. Moving the stick forward and backward (move stick to extreme forward then extreme backward position, then to neutral) moves the middle green light and moving the rudder bar (press forward the right foot then the left foot as far as possible and return to neutral) moves the bottom green light.

Move the stick sideways (match the top red light) to match the top green light with the top red light. Get it directly underneath. If it is off to one side like this (demonstrate a radial, or diagonal, matching), it will not work. Then hold the stick in position to keep the top lights matched while you move it forward or backward (match the middle red light) to match the middle light. Then hold the stick steady while you match the bottom lights with the rudder bar (match the bottom red light). When you have matched all three lights, a new setting of red lights will appear (hold controls steady after lights have changed, to give candidates opportunity to notice that the red lights have changed position). Go right ahead and match the new setting of red lights without bothering to come back to neutral. (Match the top red light while maintaining the last elevator and rudder positions, then permit all three controls to return to neutral.)

If a green light goes off altogether, as in the top row at present (demonstrate), move the control a little and the light will come on again (demonstrate). If you move any one of the controls as far as it will go (move the stick to the extreme right), there will be no green light. You must ease back the stick a bit to find the end green light (demonstrate). Do you have any questions? (Turn off

The lights. In answering questions repeat appropriate parts of preceding instructions if possible)³⁸

Variations in individual components of like equipment, built-in at the time of manufacture, or induced through normal wear and deterioration, resulted in varying average scores for individual apparatus. As an example, the effective widths of twenty-four Complex Coordination Test apparatus were measured and compared with the average score obtained on the apparatus. (Effective contact width being the portion or per cent, of an electrical contact which is capable of closing an electrical circuit and signaling correct student response.) The maximum effective width measured was 95.42 per cent. On this apparatus cadets obtained a mean score of 74.44. The minimum effective width measured was 76.25 per cent, on which cadets scored an average of 59.22. Intermediate effective contact widths and mean scores varied in direct proportion.³⁹ Pneumatic time-delay relays, control pressure, and calibration variances, likewise caused variations in mean test scores by apparatus. Variations resulting from mechanical differences were combated by a program of "quality control" during manufacture, improved maintenance, periodic calibration of the apparatus, and a system of monitoring the mean score of each test apparatus.

Retest scores repeatedly showed marked improvement in performance. Cadets demonstrated significant retention of specific learning established during the first test. Initial performance of the retest was frequently equal to, or better than, the terminal performance on the original test.⁴⁰ Similarly, cadets who had previous flying experience scored significantly higher on the Rudder Control Test than did cadets who had not flown.

³⁸Ibid., p. 103.

³⁹Ibid., p. 113.

⁴⁰Ibid., p. 73.

⁴¹Ibid., p. 442.

This is to be expected, since the Rudder Control Test was originally designed as an anti-groundloop trainer, and a direct transference of habits from flying training to control of the movements of the test fuselage by rudder pedal movements should be expected.

The mechanical and administration problems described above were largely overcome as testing progressed. Improved equipment, better maintenance, and refined administration procedures all combined to improve the test program. Another problem which may have prevented the apparatus test program from obtaining more effective results, resulted from the fact that the science of psychological testing was not sufficiently advanced in 1941 to provide the basic dimensions or "factors" which influenced the psychomotor performance of individuals. As a consequence, apparatus tests were developed largely on the basis of limited data or "hunches."⁴² It would appear, however, that the psychologists did their job well, as evidenced by the proven validity of the tests in predicting pilot success during this period. Whether the scores would have proven to be better predictors if developed from a foundation of previous basic research on psychomotor characteristics, will never be known.

Apparatus testing was originally conducted at three classification centers. In 1943, the testing program was expanded to include seven Basic Training Centers. This expansion resulted from a change in the method of processing candidates for aircrew training. Volunteers were given five months of college prior to preflight school. The seven additional test centers were established in order to test these men

⁴²Stanines, p. 986.

at the Basic Training Centers and save the expense of sending candidates to college training who might be rejected later.⁴³ The fact that three centers would have been able to test all of the aircrew candidates who were given the ACB during World War II attests to the capability of a few centers using a limited number of apparatus to test large numbers of men. A small number of testing centers appears to be the most efficient and economical way of conducting apparatus testing, even though it may not be the most convenient.

An analysis of the World War II test programs indicates that the battery of apparatus tests was approximately equal in efficiency to the battery of written tests in predicting success in pilot training. In terms of statistical significance, however, a score derived from both tests together yielded a prediction efficiency which was greater than for either test taken alone.⁴⁴ A comparison of the correlation coefficients of the written AFOQT-64 and the World War II ACB, tends to support this conclusion.

Even though apparatus testing had proved to be a reliable predictor, it was discontinued in 1955. In the words of Dr. Robert E. Miller, research psychologist for the U. S. Air Force Personnel Research Laboratory, "they were discontinued because their contribution to prediction was not sufficient to justify the considerable difficulty and expense of maintaining them in numerous examining centers."⁴⁵ There is reason to believe that "the considerable difficulty," as stated by Dr. Miller, and described above, may have been caused mostly by the poor

⁴³AAF Report no. 4, pp. 58-61. ⁴⁴Ibid., pp. 983-4. ⁴⁵Miller.

quality of equipment used during the World War II test program. Dr. Miller further states that:

It is now considered possible that most of the difficulties could be overcome by the use of apparatus having a more sophisticated design than the apparatus of several years ago. For this reason, there is a renewed interest in psychomotor testing.⁴⁶

An example of this renewed interest is reflected in one of the recommendations of Col. Emmert Lentz, Chief of the Life Sciences Division of the U. S. Air Force Inspector General's Office. After investigating four years of "cause undetermined" aircraft accidents, Col. Lentz concluded that we should establish a psychomotor performance requirement for pilot training to measure the extent to which psychomotor sequential performance deteriorates under stress or synthetic stress.⁴⁷ It is also interesting to note that selection batteries for both Mercury and Gemini astronauts included the Complex Behavior Simulator which is an electronically operated and recorded console designed to measure psychomotor functioning as well as resistance to frustration and reaction to stress.⁴⁸

In view of the preceding, it is apparent that apparatus testing, in conjunction with written testing, improved the validity of the pilot aptitude test program during World War II. It is reasonable to assume that apparatus testing would improve the validity of current aptitude tests if it were a part of the present selection criteria. The elimination

⁴⁶Ibid.

⁴⁷Emmert C. Lentz, Col. USAF, MC, "Human Factors in 'Cause Undetermined' Accidents," Aerospace Medicine (March, 1965), p. 221.

⁴⁸Charles A. Berry, MD, Problems of Astronaut Selection (Houston, Texas: NASA-Manned Spacecraft Center, 1962), pp. 7-13.

of apparatus tests stems from the problems associated with equipment and administration rather than from a question of the validity of the apparatus test itself.

SUMMARY

In June 1941, the U. S. Army Air Corps established the Psychological Research Agency (PRA) and gave it the mission of devising a method for predicting success or failure of prospective pilot trainees. In early 1942, the PRA had developed and implemented two tests. The first was an Aviation Cadet Qualifying Examination (ACQE) which was administered by aviation cadet examining boards throughout the country. This test served as a preliminary device for selecting cadets for aircrew training. The second test was an AircREW Classification Battery (ACB) designed for administration at classification centers to determine whether cadets who were selected as a result of the ACQE should be entered into pilot, navigator or bombardier training. The ACB consisted of batteries of written and apparatus (psychomotor) aptitude tests.

Written tests were developed to measure comprehension of mechanical principles, aerial orientation, visualization of maneuvers, knowledge of aviation information and to determine biographical data thought to be indicative of an aptitude for piloting an airplane. Apparatus tests were developed to measure those mental functions which psychologists thought could only, or best, be determined by performance tests. The results of a series of different apparatus and written tests were combined to establish an overall ACB pilot aptitude score. The entire ACB test required approximately eight hours to complete. Individual written

and apparatus tests were continuously analyzed for validity throughout the World War II testing program. New tests were developed, tested and substituted for less effective ones. Results of the testing program proved that written and apparatus tests are each capable of predicting success in pilot training; however, a combination of both types of tests yields a better prediction than either alone. The accuracy of individual apparatus tests for predicting success in pilot training was quite remarkable, in view of the fact that they were accomplished as fifteen minute sub-tests of the eight-hour ACB test.

The ACB test score was such a good predictor of overall success in pilot training that its function was changed from that of a classification device (to indicate whether a cadet was best suited for pilot, navigator or bombardier training) to that of a selection device for determining basic pilot, navigator or bombardier potential. Minimum "cut off" scores were established throughout the war in keeping with the availability of applicants and the requirement for aircrew members.

Several problems peculiar to apparatus testing emerged during the test program. Apparatus scores were found to be affected by variations in equipment components. This was due to manufacturing variations, wear, and to variations in instructions to the students. Most of the problems were overcome by standardized procedures, control of manufacturing specifications, and by a program of maintenance and apparatus calibration.

The PRA test development program was curtailed at the end of World War II, and the small remaining staff compiled a nineteen volume history of the testing program. The ACB continued in use until 1955, when the U. S. Air Force implemented the Air Force Officer Qualifying

Test (AFOQT), which is a written aptitude test similar to the written portion of the ACB. Apparatus testing was discontinued at this time, primarily to eliminate the expense and inconvenience of maintaining testing centers. A degradation of the selection effectiveness when using the written test alone was expected. This reduction in efficiency is evident when we compare the capability of the current AFOQT and the World War II ACB test. The U. S. Army and the U. S. Navy use written aptitude tests similar to the U. S. Air Force AFOQT as a basis for selecting applicants for pilot training. The written aptitude test, therefore, is the only test currently being used by the United States military services to specifically evaluate pilot potential.

CHAPTER III

INVESTIGATION OF OTHER PROCEDURES APPLICABLE FOR USE IN SELECTION OF PILOT TRAINEES

Two distinct types of tests for selecting and classifying aircrew applicants evolved during World War II--written aptitude tests and apparatus (psychomotor) aptitude tests. Apparatus tests have been discontinued. The written aptitude test remains today as the only selection method used for estimating success in pilot training. Current elimination rates indicate that the written aptitude test alone is not capable of selecting pilot training applicants with the accuracy necessary to preclude significant eliminations. This chapter is devoted to an examination of other procedures which might be used to augment or replace the written aptitude test in order to achieve greater success in screening pilot trainees.

Light Plane Training and the Flight Instruction Program

In 1952, Headquarters U. S. Air Force requested that the Air Force Personnel and Training Research Center initiate a project to evaluate the light plane as a selection and training device.¹ The resulting

¹Eli S. Flyer and Lawrence R. Bigbee, The Light Plane as a Pre-Primary Selection and Training Device: III (Lackland AFB, Texas: Air Force Personnel and Research Center, 1959), p. 1.

experiment was conducted in the following manner. Two hundred and forty aviation cadets, who had no previous flying experience, were selected at random from the pool of applicants available for classes 53-D through G (graduating in 1953). Selection was made in such a way that stanine scores (three through nine) were represented in proportion to the parent population. One-half of the subjects at each stanine level were then randomly assigned to the experimental group, and the other half to the control group.² The one hundred and twenty students comprising the experimental light plane group were given sixteen hours of dual instruction, six hours of solo, and three hours of check flights during their six weeks of preflight training.³ The control group participated in the same preflight program but received no light plane training. Both groups entered primary at the same time and proceeded through the usual curriculum. A civilian contractor provided the necessary facilities, equipment, Aeronca "Champion" aircraft, maintenance, fuel, oil, instructors and supervisors.⁴

Several indicators of student performance were collected during light plane training for later correlation with primary and basic flying. Instructors maintained a scored daily progress record sheet on each student and made subjective predictions on a six point scale from a low of "virtually certain to be eliminated in primary" to a high of "virtually certain to be a superior student." These estimates were collected at the fifth, fifteenth and twenty-fifth hour of light plane training.

²Everett L. Sutter and others, The Light Plane as a Pre-Primary Selection and Training Device: II (Lackland AFB, Texas: Air Force Personnel and Training Center, 1954), p. 1.

³Flyer, p. 2. ⁴Ibid.

During each flight check, the check pilot made a similar subjective prediction using the same six-point scale.⁵ Records of elimination from training were maintained on both groups. When the experiment was completed, several significant findings emerged.

Experimental group students were eliminated significantly earlier than control group students when all began flying in the primary phase. Eleven of the experimental group students were eliminated before eighteen flying hours, as compared to only two control group students. Between the eighteen and sixty hour points in training, seven of the experimental group were eliminated as compared to thirty-four control group students.⁶ It would appear that light plane training assists in earlier elimination. The reasons for elimination were not analyzed, however, since the experimental group already knew how to fly. This early elimination would tend to indicate the student's loss of desire for pilot training, rather than the difficulty of the first hours of primary pilot training. An additional finding was that light plane training does not appear to provide a student with a prolonged advantage over students not receiving this type of training. Differences in measured proficiency in favor of the experimental group at the eighteen-hour level had disappeared by the sixty-hour level of training.⁷ Of particular interest is the fact that there was no marked difference in the pilot aptitude scores of the eliminees in the two groups. Although the rates of attrition of experimental and control group students were different, there was no evidence of greater attrition of low aptitude

⁵Ibid., pp. 2-4. ⁶Sutter, p. 4. ⁷Ibid.

students in the control group as compared to the experimental group.⁸ Instructors and check pilots were able to predict future student flying performance at a point in training as early as five hours, although an additional ten to twenty hours of training increased the accuracy of prediction. Instructor and check pilot predictions, in combination with the pilot aptitude stanine scores, apparently provide a more accurate prediction than either can alone.⁹

The Flight Instruction Program (FIP) began when the Eighty-Fourth Congress enacted Public Law 879 in 1956. Chapter 830, "ROTC Programs-Flight Instruction," states:

The Secretary of the Army and the Secretary of the Air Force, may for a period of four years after the effective date of this amendatory act, provide, or contract with civilian flying or aviation schools or educational institutions to provide such personnel, aircraft, supplies, facilities, and instruction as are necessary for flight instruction of members of the ROTC in the Army and Air Force units, respectively.¹⁰

A similar paragraph gave the Secretary of the Navy authorization to provide the same training for Naval ROTC. Training was subsequently authorized beyond the original four years, and today all three services are conducting FIP training in conjunction with advanced ROTC training. Each interprets the objectives of the FIP program somewhat differently, as evidenced by their respective governing regulations. U. S. Air Force Regulation number 45-58, Air Force Flight Instruction Program, states that the objectives of the FIP program are to:

Motivate qualified Air Force ROTC Cadets to a career in the Air Force.

⁸Ibid., pp. 4-5. ⁹Flyer, pp. 5-8.

¹⁰United States Code: Congressional and Administrative News, 84th Congress-Second Session 1956 (Brooklyn, N. Y.: Edward Thompson Co., 1956), p. 940.

Encourage qualified basic course Air Force ROTC Cadets to enroll in the advanced course as pilot training applicants.

Provide a screening device which will identify pilot training applicants who lack the basic aptitudes for Air Force pilot training.¹¹

U. S. Army Regulation number 145-355, Flight Instruction, states that the mission of Army ROTC Flight Instruction is to:

Stimulate interest in Army aviation and in the Army as a career. The flight instruction will be of sufficient scope to qualify selected students in the basic principles of contact flying.¹²

The Bureau of Naval Personnel Instruction number 1533.43F, NROTC Flight Instruction Program. lists the two primary purposes of Naval ROTC FIP as:

To motivate Naval ROTC students toward a naval aviation career.

To act as a relatively inexpensive screening device which eliminates from further flight training consideration those young men who are not aeronautically adapted.¹³

The reader may question why the FIP is not discussed in the preceding chapter, since one of the stated objectives of the FIP is to "provide a screening device which will identify pilot training applicants who lack the basic aptitudes for . . . pilot training."¹⁴ FIP screening is applied only to those pilot trainees entering from ROTC

¹¹U. S. Air Force Regulation 45-58, Air Force ROTC Flight Instruction Program (FIP) (Washington, D. C.: Department of the Air Force, 1 Sep 1961), p. 1.

¹²U. S. Army Regulation 145-355, Flight Instruction (Change 4; Washington, D. C.: Department of the Army, 27 Jan 1964), p. 2.

¹³U. S. Navy BUPERS Instruction 1533, 43F, The NROTC Flight Instruction Program (FIP) (Washington, D. C.: Department of the Navy, 7 Oct 1965), p. 1.

¹⁴AFR 45-58, p. 1.

training. Because the application is not uniform the author has chosen, perhaps arbitrarily, to consider FIP in the category of a procedure which can be applied toward screening all pilot training applicants.

Although there are minor variations between services, the basic FIP provides approximately thirty-six and one-half hours of student flying. The U. S. Air Force specifies a maximum of twenty hours dual, fifteen hours solo and one and one-half hours for a final flight check.¹⁵ The U. S. Army allows an additional three hours to meet unforeseen contingencies,¹⁶ and the U. S. Navy stipulates a maximum of forty flying hours.¹⁷

The flight curriculum is based on Federal Aviation Agency (FAA) Regulations Part 141 (Primary Flying School Curriculum). The standards described therein are official for the FIP.¹⁸ Each ROTC detachment commander who is authorized FIP, contracts with a FAA certified flight school which possesses an Airman Agency Certificate with a Primary Flying School rating.¹⁹ Aircraft and all flying instruction are provided by the civilian flying school under government contract. Operational supervision of the FIP program is the responsibility of the FAA. Responsibility is defined in the U. S. Air Force ROTC Manual number 45-2, Air Force ROTC Cadet Flying Programs, as follows: The FAA--

When required, provides the Air Force with a list of eligible flight schools in each area to be served. These schools are required to possess and keep in effect at all times an Airman Agency Certificate with a Primary Flying School rating as issued under the provisions of Federal Aviation Regulations Part 141.

¹⁵U. S. Air Force ROTC Manual 45-2, Air Force ROTC Cadet Flying Programs (Maxwell AFB, Alabama: Air University, 1 Oct 1965), Ch. 2, p. 8.

¹⁶AR 145-355, p. 10. ¹⁷BUPERS 1533.43F, p. 2.

¹⁸AFROTCM 45-2, Ch. 2, p. 1. ¹⁹Ibid., Ch. 2, p. 3.

Provides lists of aircraft and instructors, as required.

Orients the flight schools in the flight curriculum to be used and the standards to be maintained. The flight curriculum is a part of the applicable FIP contract. This curriculum fulfills USAF and FAA requirements, and students trained in this program may be eligible to apply for the FAA Private Pilot's Certificate, provided they successfully complete the FAA written examination.

Maintains a continuous operational inspection of the flight schools, instructors, and aircraft to insure adherence to all prescribed standards.

Performs a minimum of 10 percent of the required periodic progress checks and all of the final flight progress checks and submits copies of AFROTC Form 95 to the appropriate authorities. When more than one detachment utilize the same flying school, FAA will perform 10 percent of all FIP progress checks at that flying school.

Administers and scores the written examination required of those cadets who apply for a FAA Private Pilot's Certificate.²⁰

A cadet is given two "screening checks" and one final check.

The U. S. Air Force requires a forty-five minute "screening check" at the nine and one-half and nineteen hour points. The student who passes the final flight check has successfully completed the FIP.

FAA does not require formal ground training of student pilots; however, it does require that the student be familiar with certain visual flight rules before soloing, and with minimum flight planning elements before flying outside of the local area.²¹ Each ROTC detachment commander is responsible for providing the necessary ground school instruction separate from the flight instruction. The U. S. Army specifies thirty-five hours of ground instruction.²² The U. S. Navy requires approximately thirty-five hours, but not to exceed fifty hours.²³

²⁰Ibid. ²¹AFROTCM 45-2, Ch. 2, p. 31. ²²AR 145-355, p. 10.

²³BUPERS 1533.43F, p. 2.

The U. S. Air Force recommends an outline guide, but does not specify the hours which should be devoted to ground school.²⁴

In addition to contracting for flight training and ground school instruction, the ROTC detachment commander monitors daily scheduling and student progress, provides flying clothing and equipment, authorizes payments to the contractor, initiates evaluation proceedings, grants waivers, assists in accident investigations, interviews cadets during training, prepares periodic and year-end reports, and generally supervises the program to insure that the objectives of the FIP are attained.²⁵

Student eligibility criteria and obligation vary between the three services. The U. S. Air Force requires that all advance course students in Category I-P (pilot), who have signed a Career Reserve Statement as applicants for flying training, must participate when their school conducts the program.²⁶ Students must be within twelve months of completing all aerospace studies academic requirements. (The desired period of participation in the FIP is four months, but in no case will it exceed twelve months.) Students will have been certified physically qualified for Air Force commissioning, be able to pass a flight physical, and will have an FAA Medical Certificate, third class (FAA Form 1004.1), prior to initial solo.²⁷ The ROTC cadet must have passed the AFOQT with the following minimum scores: Officer Aptitude-ten; Pilot Aptitude-twenty-five; and Navigator Aptitude-twenty-five.²⁸ This compares with

²⁴AFROTCM 45-2, Ch. 2, pp. 33-35. ²⁵Ibid., Ch. 2, pp. 2-39.

²⁶AFR 45-58, p. 1. ²⁷AFROTCM 45-2, Ch. 2, pp. 4-5.

²⁸Information provided by Maj. James B. Sampson, Air University, Maxwell AFB, Alabama. 4 Aug 65.

minimum AFOQT scores of twenty-five in each category, for applicants to U. S. Air Force pilot training. ROTC cadets participating in the FIP will not be commissioned until the Professor of Aerospace Studies has received confirmation of the cadet's successful completion of the FIP, or evaluation action has been completed.²⁹

The U. S. Army requires that a student pilot be in his fourth year of Senior Division ROTC, with sufficient time remaining in school to complete the program prior to graduation, and have a sufficiently high academic standing to be recommended by his dean and Professor of Military Science. Headquarters, Department of the Army, informs the United States Continental Army Command of the following academic year's quotas by 1 January of each year. Quotas are then sub-allocated to the numbered armies, and then to academic institutions within the army area. An institution must enroll a minimum of five students in order to establish a FIP program, or secure training at a cost per student comparable with a five student program.³⁰ Instruction will be completed within a four month period, if possible, and will not exceed nine months.³¹ Physical requirements are compatible with aviation training, and the FAA Class Three Certificate (Form 1004.1) is accomplished. The student is required to attain a minimum score of eighty on the AFWAB-2 test battery, which is the same score required for active duty personnel who apply for flight training.³²

²⁹AFROTCM 45-2, Ch. 2, p. 19. ³⁰AR 145-355, pp. 3-4.

³¹Ibid., pp. 6-10. ³²Ibid., p. 7.

Students selected for the Army FIP incur a definite obligation for this training. U. S. Army Regulation number 145-355, Flight Instruction, states that:

Selected students must agree that, if commissioned at the time of graduation, they will volunteer for Army aviation flight training and assignment, and that if they are enrolled in an Active Army initial flight training course of instruction, they will be required to serve on active duty as a commissioned officer for not less than 3 consecutive years from the date of course completion or termination (self or school imposed) whichever is earlier; and, if they voluntarily refuse to complete the required medical examination for aviation flight training, they will be required to serve on active duty as a commissioned officer for not less than 4 consecutive years from the date of entry on active duty. This period of required active duty will replace the 2-year period of active duty or 3- to 6-month period of active duty for training to which the student has agreed in the ROTC Deferment Agreement, or the ROTC Enrollment Agreement, whichever is applicable.

Although enrollment in the ROTC Flight Instruction Program does not commit or bind the Army to permit an individual to complete the training prescribed for that program, or when ordered on active duty, to enroll him in an Army initial flight training course, every effort will be made to insure the entry of each ROTC flight instruction graduate who enters on active duty into army aviation. Students participating in the ROTC flight instruction program will revert to the obligation assumed in their ROTC Deferment Agreement or their ROTC Enrollment Agreement, whichever is applicable, if they fail to complete the ROTC flight instruction course. Those graduates who enter on active duty and are enrolled in an Active Army flight training course must serve on active duty as prescribed above, unless sooner relieved of this obligation or discharged under regulation prescribed by the Secretary of the Army.³³

The Navy allows NROTC students to enter FIP after successful completion of the first quarter or semester of their junior year. Quotas will not exceed fifteen students annually at each participating institution without prior approval. Students must have passed the Navy flight physical.

³³Ibid., p. 6.

Applicants must have attained a score of three on both the AQT and FAR tests.³⁴ This compares with a minimum requirement of three and five, respectively, for applicants for active duty Naval pilot training.

One of the basic objectives of the FIP is to identify individuals who should not be entered into active duty flying training. Accordingly, a cadet may be eliminated from AFROTC FIP for several reasons. Medical disqualification or removal from ROTC training naturally eliminates a student from FIP. He will be eliminated if he fails to achieve a passing grade on the FAA or locally prepared written examination, or if the FAA agent administering the final flight progress check does not recommend him for further flight training. He may be eliminated for pilot inaptitude, willful violation of flying regulations, indifference to training or by a self-initiated request for elimination.³⁵

The U. S. Air Force, seeking to determine the effect of FIP training as a predictor of success in future pilot training, studied results of FIP training during the first year operation (1957). Student officers who had been given FIP training were compared with non-FIP students eliminated from primary pilot training. The study found that fifteen per cent fewer FIP students were eliminated, for all reasons, from primary pilot training than non-FIP trained students. Of those eliminated, a significantly larger proportion of the non-FIP officers were eliminated for flying deficiency. The difference between the proportions of motivational eliminees in the two groups was not significant. Table 10 compares proportions of FIP and non-FIP graduates eliminated from primary pilot training.³⁶ From these results we can reasonably conclude that FIP

³⁴BUPERS 1533.43F, pp. 1-4. ³⁵AFROTCM 45-2, Ch. 2, pp. 12-13.

³⁶John A. Cox and Cecil J. Mullins, Evaluation of Light Plane Training Among AFROTC Student Officers (Lackland AFB, Texas: Personnel Laboratory, Air Research and Development Command, 1959), p. 5.

training does reduce the proportion of elimination in pilot training due to flying deficiency, everything else being equal.³⁷

TABLE 10
PROPORTIONS OF FLIGHT INSTRUCTION PROGRAM (FIP) AND
NON-FIP GRADUATES ELIMINATED FROM
PRIMARY PILOT TRAINING

	FIP			Non-FIP		
	No. Grad.	No. Elim.	Per Cent	No. Grad.	No. Elim.	Per Cent
Flying Deficiency Eliminees	357	13	4	209	50	19
Motivational Eliminees		22	6		16	7
Total	357	45	11	209	73	26

A change in U. S. Air Force policy just at the time the test group was to graduate enabled the U. S. Air Force researchers who were evaluating the first year of FIP training to estimate the impact of the FIP on student interest in flying. The change required each man to sign a five-year active duty commitment rather than a three-year commitment before entering flying training. The alternative to not signing the five-year term was a three-year tour of active duty in a non-rated status. The implication being that those who signed the longer

³⁷ Ibid.

commitment were more motivated toward flying and more oriented toward an Air Force career. Using this logic, entry into preflight was considered a demonstration of motivation. However, the number of FIPs and non-FIPs who entered preflight was nearly the same (twenty-three versus twenty-four per cent, respectively). There would appear to be no real advantage in providing FIP training insofar as producing men with more flying or career motivation.³⁸

The light plane experiment and the results of the FIP study taken together indicate that light plane training does reduce eliminations from pilot training. This is definitely proven by the fifteen per cent reduction in the elimination rate of the FIP trained ROTC students over non-FIP students. The fact that a relatively large number of the light plane group was eliminated within the first eighteen flying hours of primary pilot training indicates that many of these would have been eliminated in light plane training, if such elimination had been authorized (the experiment did not allow eliminations, regardless of student performance). Light plane training apparently does not provide a continuing skill advantage over students who do not receive the training. The light plane experiment proved that there is no significant difference between the pilot aptitude scores of those eliminated who had received light plane training, and those who did not receive such training. It also demonstrated that instructors and check pilots could predict student success in subsequent flight training with fair accuracy. The prediction was more accurate, however, when

³⁸ Ibid., p. 4.

combined with the pilot aptitude score. Similarly, if an FAA agent passes a student on his final FIP check ride, it is considered a positive prediction of student success in future training. Again, the student's pilot aptitude score in combination with the FAA check ride is a more valid predictor of success in pilot training than either the score or the FAA agent recommendation alone. The FIP study concluded that FIP training does not increase student motivation for flying, as evidenced by the number of FIP and non-FIP graduates who actually entered preflight training. This is further substantiated by an analysis of the reasons for eliminations. In the "motivational eliminee" category both FIP and non-FIP students were eliminated at almost the same rate--six and seven per cent, respectively--while in the "flying deficiency" category eliminees were much lower in the FIP trained group.

Personal Interviews

The personal interview is widely used for personnel recruiting by industry and should be evaluated as a possible procedure for improving the selection of pilot applicants. Personal interviews were used by the Army until World War II as part of the screening procedure for selecting aviation cadets. Interviews were discontinued with the introduction of written and apparatus tests in 1941. None of the services are using interviews to screen for pilot potential at present, and there is no indication that they will in the future.

An experiment was conducted during World War II to see if interviews could be used to identify students with high pilot aptitudes test scores,

who would fail, and those with low scores, who would succeed, in flying training. Research indicated that interview procedures cannot identify these individuals.³⁹

The U. S. Air Force developed an interview procedure employing three-man boards to be used in all officer procurement programs. These boards reviewed, on an experimental basis, U. S. Air Force ROTC cadets and on applicants for pilot training. The U. S. Air Force study group recommended that interview procedures not be used where other kinds of measures of known validity are available, and if interview scores are determined, they should not be included in a selection composite. The study group recommended that the interview procedure be used only as a screening device, so that the few applicants possessing obvious undesirable characteristics could be eliminated from further consideration.⁴⁰

Establishing proficient and standardized interview boards, which are available continuously at convenient places to screen pilot training applicants nationwide, obviously presents many problems. Based on the historically poor correlation of interview ratings and success in flight training, and the complexity of administering interviews, there is little reason to believe that the interview can be a useful method of selecting applicants for pilot training.

³⁹ Ernest C. Tupes and Raymond E. Christal, Psychological Tests and the Selection and Classification of Air Force Officers (Lackland AFB, Texas: Air Force Personnel and Training Research Center, 1957), p. 4.

⁴⁰ Michael A. Zaccaria and others, Development of an Interview Procedure for USAF Officer Applicants (Lackland AFB, Texas: Air Force Personnel and Training Research Center, 1956), pp. 1-3.

Psychological and Psychiatric Testing

Psychologists and psychology were injected into the aviation cadet selection program in 1941 when the Army Air Corps Psychological Research Agency was directed to devise a method for predicting success in pilot training. Successful written and apparatus tests were developed under psychologists direction. The pattern which they established has been continued and is being used today, as noted in Chapter Two. This does not mean, however, that psychological testing is presently being used in selection of pilot training applicants. For the original tests, psychologists worked with specialists in pilot training to construct tests designed to measure those aptitudes thought to be possessed by successful pilots. If a high test score correlated with success in pilot training, and low scores with eliminations, the test was incorporated into a test battery. Poor predictors were discontinued. The cycle of research, test development, validation, and revision of the test battery has been continuous.⁴¹ The author does not wish to imply that such trial-and-error method has been ineffective, for pilot aptitude scores have a high validity when compared with all industry-armed forces aptitude tests.⁴² The point is, that current written pilot training screening tests of all services are aptitude oriented, as opposed to orientation on the more subjective psychological aspects of a man's intellect.

⁴¹Stanines: Selection and Classification for Air Crew Duty (Washington, D. C.: HQ., Army Air Forces, 1946), pp. 16-7.

⁴²A. L. Kubala, Adaptability Screening of Flying Personnel (Randolph AFB, Texas: Air University School of Aviation Medicine, 1958), p. 2. Pilot aptitude scores have a validity of 0.50 as compared with a median validity of industry-armed forces aptitude test score average of 0.25.

There are two reasons why testing has not advanced beyond aptitude measurement. First, the services have not felt compelled to improve the system, since pilot aptitude scores have been fairly reliable as predictors. However, some students with high aptitude scores are still eliminated from training. This does not necessarily indicate that the aptitude score is an inaccurate predictor; it simply indicates that there are other unmeasured factors causing eliminations.

The second reason why testing has not advanced beyond aptitude measurement is that psychological-psychiatric testing poses significant problems. Aptitude testing is concerned with determining instrument comprehension, mechanical principles, etc., which relate quite directly to the flying environment. In psychological testing, however, the problem is more abstract. For example, how can you test the ability to adapt to severe environmental pressures? How do you discern whether a man's reaction to an inflight emergency will be calm and methodical, or whether he will panic, especially when the man does not know how to fly at the time you are testing him? The task of the psychologist is to discover what characteristics are determiners of desired traits (to remain calm in this case) and to develop means to measure this characteristic. Then the relevance or validity of the measured characteristics must be proven by correlating them with success or failure. Proof of validity is more difficult for psychological tests because, as in the case of aptitude testing, the end result (graduation or elimination) may not correlate with individual reaction to psychological pressures: i.e., it will not always be true that those who are graduated remained calm during emergencies, and those who were eliminated, panicked. Validation would probably require continuing analysis of an individual for several

years beyond training, because of the infrequency with which significant validating events occur. The apparent difficulty with this type of testing probably explains why little research or study of psychologic or psychiatric testing is being applied to improve selection of pilot trainees.

Research of this type, has been relatively unproductive. The U. S. Air Force School of Aviation Medicine contracted for one investigation to evaluate the Human-Figure Drawing Test as an objective psychiatric screening aid for use with student pilots. It concluded that the test provided no evidence of validity as a screening aid for student pilots, although this may reflect, partially, the manner in which the experiment was conducted.⁴³ Students were evaluated by psychologists using only the drawings and a checklist. The psychologists did not observe the students doing the drawings, which reflected an assumption that it would be impractical for a psychologist to observe each student during the figure drawing, if it were included in a test battery.

Stress and Motivation Testing

There are two areas of psychological testing which appear to warrant further research. One is the area of "stress" testing and the other can be referred to as "motivation measurement."

⁴³Anne Anastasis and John P. Foley, Jr., Psychiatric Selection of Flying Personnel (Randolph AFB, Texas: USAF School of Aviation Medicine, 1952), pp. 1-13.

Stress is not an element of present examination procedures. It is doubtful that a written examination is capable of introducing a stress situation and measuring an individual's reaction to it.

Col. John P. McCann, Deputy Surgeon of Air Training Command, states that stresses associated with flying have certain peculiarities which, if not unique, are at least accentuated by the flying environment. The most disturbing stress is the frequency and rate of change in both direction and amplitude of accelerative forces. Second, the student becomes aware of the fact that he is in an environment which demands continuous motion if he is to survive. He can neither stop nor go backward. Every student must adapt to these two factors if he is to complete the training.⁴⁴

The student's encounter with these two environmental factors begins with his initial flight mission. He receives his first exposure to accelerative forces on the take-off roll. The cockpit environment is ready made to precipitate fear and anxiety-- a myriad of dials, lights, and levers which are seen as a single mosaic, high intensity noise, temperature and vibration levels, numerous verbal commands from instructor and tower, plus a confused recollection of "do's" and "don'ts", received at the pre-mission briefing. This may cause hyperventilation, profuse perspiration, and muscle tension in the most well adjusted student. As the brakes are released the student feels himself pressed to the back of his seat, and he perceives a sensation of power and force that is new and disconcerting. During the flight, voluntary and involuntary aircraft movements begin to subject the student to new and uncomfortable

⁴⁴John P. McCann, Col., USAF, MC, "Aviation Psychology in Flying Training.", The United States Air Force Medical Service Digest, XVI, no. 1 (1965), pp. 2-8.

sensations, predominately uneasy feelings in the pit of the stomach associated with negative G forces and the tense fatiguing experience associated with positive G forces. These disturbing stimuli, and the apprehension which accompanies them frequently bring about airsickness. The apprehension and discomfort caused by airsickness may cause further airsickness, and the cycle is repeated. To some degree this course of events happens to approximately forty per cent of the U. S. Air Force pilot trainees.⁴⁵ Most students overcome this malady in the first few days; however, in the cases studied by Col. McCann, airsickness was the dominant factor in fourteen per cent of the failures.

Since learning ability is directly influenced by airsickness and apprehension, both must be under control before much progress can be made in the learning process. If they are not overcome, failure will occur when the student definitely falls behind his classmates. The elimination procedure categorizes student failures as being due to medical deficiencies, academic deficiencies, or flying deficiencies. However, Col. McCann states that:

In almost all cases, however, there is substantial evidence to indicate that each is basically a stress failure. The student merely, consciously or unconsciously, handles his stress in a different manner and utilizes a different avenue of exit to escape from his uncomfortable situation.⁴⁶

Testing under conditions of stress might also have a post-training application. During the Korean War the U. S. Air Force initiated a

⁴⁵ Ibid. ⁴⁶ Ibid.

study to determine why a small per centage of the F-86 pilots accounted for over half of the MIG kills.⁴⁷ In commenting on reaction to stress, the study concluded:

Those who were most successful in destroying enemy aircraft reported that their efficiency tended to improve in important situations. The less successful more frequently reported no change in their efficiency or an actual deterioration of efficiency when confronted with important situations.⁴⁸

In the 1962 selection program for Gemini astronauts, all applicants were tested on the Complex Behavior Simulator. It is a large, electronically operated console designed to measure psychomotor functioning as well as resistance to frustration and reaction to stress. The speed at which some fourteen signals are presented to the subject can be varied. In this test, all applicants were carried to a speed which overtaxed their performance capability in order to measure their reaction to stress.⁴⁹ The results were evaluated as part of an extensive test program, and none of the candidates were eliminated or retained solely on the basis of this test. The interesting fact is that the program managers consider a psychomotor (apparatus) test with a stress factor a meaningful test to evaluating candidates for astronaut training.

Measurement of individual reaction to stress, if incorporated in the selection process, should make a significant contribution toward elimination of unsuitable applicants. Present tests primarily measure mechanical aptitude for piloting an aircraft. There can be no question

⁴⁷ 9.7 per cent of the F-86 pilots accounted for 55.2 per cent of the total MIG kills.

⁴⁸ Paul Torrance and others, Factors in Fighter-Interceptor Pilot Combat Effectiveness (Lackland AFB, Texas: Air Force Personnel and Training Research Center, 1957), p. 21.

⁴⁹ Berry, pp. 7-13.

that acceptable mechanical aptitude is a prerequisite for pilot training. However, aptitude and the ability to adapt to the stresses and the anxieties of flying do not seem to be directly related. A valid method of measuring individual adaptability to stress situations appears to be a necessary addition to our testing program if recruiters are to identify those individuals who possess the mechanical aptitude for piloting, but who might be eliminated for other reasons.

Motivation, as with any endeavor, is an important factor in overcoming the obstacles in learning to pilot an aircraft. The story of Douglas Bahder, who returned to combat flying with the Royal Air Force after losing both legs, is testimonial to the force of strong personal motivation to fly. F-86 aces in Korea considered motivation an extremely important determinant of success in air-to-air combat. Investigation reveals that most of the aces had exerted unusual efforts to obtain assignments to fighter units. Singleness of purpose and intensity of effort were characteristic of all of their lives.⁵⁰ Motivation was also one of the criteria for selecting astronauts for project Mercury. One might think that the background of the astronaut candidates--most were jet test pilots--would be ample evidence of motivation. The approach taken by NASA was that the necessity for assessment of motivation for space operation was much simplified, but not eliminated by the pre-selection criteria.⁵¹ Motivation, therefore, is considered an important factor for individual success in pilot training, in combat, and in astronaut selection. Motivation measurement is not a part of the present selection procedure for military pilot training.

⁵⁰Torrance, p. 30. ⁵¹Berry, p. 5.

Since present selection procedures concentrate on identifying aptitude for pilot training, a logical question to ask is, "what relationship exists between aptitude and motivation?" Apparently there is very little. The U. S. Air Force conducted a study among AFROTC students to determine, in part, the motivational variables which are relevant to application for flying training. The report stated "it is probable that further research designed to reveal relationships between aptitudes in general and motivation for flying will not prove very fruitful."⁵² A similar study conducted by the U. S. Navy compared attitudes with success in flight training. From a prepared list of statements seven hundred aviation cadets selected their reasons for entering naval aviation. To illustrate, the choice most often selected by the successful group was:

I have always been interested in aviation, but never had a chance to follow it up. I thought this a wonderful opportunity to fulfill my ambition.

The choice most often selected by the unsuccessful group was:

Naval aviation seemed the best way for me to get a commission and all of the assets connected with being an officer.⁵³

Conclusions reached by the researchers were: cadets who enter Naval Air Training with only an incidental interest in flying are more likely to withdraw voluntarily; cadets who indicate a long standing interest in aviation have greater chances of remaining in training; and, the best training risks for naval aviation are those young men

⁵²Ernest C. Tupes, J. W. Bowles and Donald V. Torr, Predicting Motivation for Flying Training Among AFROTC Cadets (Lackland AFB, Texas: Air Force Personnel and Training Research Center, 1955), pp. 1-6.

⁵³John T. Bair and Clinton H. Maag, Attitudes Toward Entering Training as Predictors of Motivation Among Student Aviators (Pensacola NAS, Florida: U. S. School of Aviation Medicine, 1953), p. 4.

who feel that flying fulfills important goals for them.⁵⁴ Aptitude was not correlated directly in the U. S. Navy study; however, all of the cadets involved are presumed to have obtained a passing score on the aptitude tests or they would not have been in training.

Motivation and aptitude, then, both appear to be key factors for determining success in pilot training. Research indicates that these factors are independent of each other. This may not be true of the relation between motivation and stress.

Doctor Berry, writing on the problem of selecting astronauts, states that ". . . tolerance of stress is a direct function of strength of motivation . . ."⁵⁵ A series of psycho-physiologic stress tests were administered to the Mercury astronauts to determine if they would suffer performance decrement or sustain irreversible trauma. These tests gave many indications of the manner in which the candidates habitually handled stress both physiologically and psychologically.

The responses also gave valuable information on the subject's motivation. The relationship between stress and motivation is of particular interest. If it were true that there is a direct correlation between an individual's capacity to perform under stress conditions (as part of a selection test) and motivation for flying training, two significant factors could be evaluated with one test.

Motivation and stress tolerance are relatively more abstract than aptitude testing. There seems little likelihood of satisfactorily testing stress with a written test, although an apparatus test, properly designed,

⁵⁴Ibid., pp. 1-5 ⁵⁵Berry. ⁵⁶Ibid., p. 8.

could measure responses indicating the student's limit of rational action. Such a test, administered as part of the selection test battery, would have the additional element of stress introduced by being part of a competitive examination. Motivation measurement could probably be satisfactorily accomplished by a properly designed written examination. Research will be necessary to substantiate or alter these assumptions.

Absence of stress and motivation testing, then, appear to be the major deficiencies in the present system of selecting men for pilot training. An acceptable level of pilot aptitude must, of course, be the first consideration in determining eligibility of pilot training, and the present written aptitude tests determine this quite well. However, this ought to be considered only the first hurdle rather than complete qualification. The next question, needing resolution is whether the man can perform under the stress conditions which he will face in his day-to-day course of training, as well as throughout his pilot career. If this can be determined, the final question is: "will he? Does he have the desire--the motivation--to apply his total effort to the training program and to his operational flying assignments?" A composite score, including properly weighted aptitude, stress, and motivation scores, should represent a more accurate indication of an applicant's potential than does the present aptitude score alone. Hopefully, adequately researched and designed tests, in combination with a revised weighting and "cut-off" score, can identify more of those men who will be eliminated if they enter pilot training.

Summary

An improved version of the written aptitude test developed during World War II is the only test for pilot potential currently being used by all services.

The U. S. Air Force conducted an experiment to determine the value of the light plane as a selection device for further pilot training. This study concluded that light plane trained students were eliminated significantly earlier during pilot training than students without light plane training, and that light plane trainees retained no measurable proficiency advantage at the completion of pilot training. Significantly, there was no difference between the pilot aptitude scores of the students eliminated in either group.

In 1956 the U. S. Congress authorized the Flight Instruction Program (FIP) for ROTC students in all service programs. The objectives of the program are to motivate students for ROTC and subsequent military careers, and to screen for pilot aptitude. ROTC detachments are responsible for contracting a thirty-six hour flight training program from a civilian flying school and for providing ground school. The Federal Aviation Agency (FAA) is responsible for certification of the participating flying schools and for administering final check rides. Successful completion of the flight program fulfills the FIP requirement, and the student is then eligible for a private pilot's license, although this is not a requirement of the program.

The U. S. Air Force conducted a study of the first FIP class in order to determine effectiveness of the FIP. This study revealed that fifteen per cent fewer FIP-trained ROTC students were eliminated from

pilot training, than non-FIP trained ROTC students. The decrease in attrition was mainly in the "flying deficiency" category. "Motivational deficiency," as a cause for elimination, remained the same. An analysis of ROTC students who entered flight training indicated that FIP training apparently does not motivate students for flying or for an Air Force career.

By combining the results of both studies, one can conclude that light plane training does significantly reduce eliminations from pilot training, and that light plane training does not appear to motivate students for further pilot training.

Personal interviews, as a method of estimating piloting potential, were discontinued early in World War II. Subsequent studies have indicated that interviews are very ineffective predictors. Considering the inherent administrative problems, and their lack of validity, there seems to be no practical application of interviews to the pilot training selection process.

Psychological and psychiatric testing have not been used in the selection process. This is due, partly, to the emphasis that has been placed on aptitude testing, and partly because test experiments in the field have been unsuccessful.

Testing of an applicant's capability to perform under stress conditions, and measuring individual motivation for flying, are not included in the present selection method. Anxiety and stress are magnified by the nature of the flying environment. There is evidence

to indicate that the majority of eliminations from pilot training result from stress failures. Motivation is a positive factor in reducing eliminations. If a trainee feels that flying fulfills important goals for him, his chances of succeeding in flying training are greatly improved. There appears to be no relationship between pilot aptitude and stress failures, or between pilot aptitude and motivation. The lack of a test to evaluate the potential for stress failure, or to measure an individual's motivation for flying will preclude further significant improvement in the current "aptitude oriented" selection method.

CHAPTER IV

CONCLUSIONS

Chapters I through III reviewed and analyzed procedures which have been, or could be used to select men for pilot training. This chapter will state and support conclusions drawn from that review and analysis.

Retain Written Aptitude Test

The first conclusion is that written aptitude tests, as presently used in the selection method, should be retained. All military services currently administer written aptitude tests to applicants and require a specified minimum score as a selection criterion. Due to the differences in military pilot training programs and the varying attrition by type of input (ROTC, OTS, AOC, Academy, Rated, active duty, etc.) within each program, it is difficult to determine a single statistically meaningful average elimination rate, however, it can be stated that approximately fifteen to twenty per cent of all entries are being eliminated from the various flying training programs.¹ While this percentage is an approximation, it compares favorably with the fifty

¹Average eliminations by service: U. S. Air Force --17.6% for year ending Oct. 65; U. S. Army -- 11 & 19%, resp., for officers and warrant officers for FY 65; and U. S. Navy -- 21.7% for FY 65.

per-cent elimination rate prior to World War II, when aptitude tests were not used. Since the written aptitude test is the primary method of establishing eligibility for pilot training in the current selection system, it must be concluded that the aptitude test is reducing eliminations, and therefore it should be continued. In addition, the aptitude test, being entirely a paper-and-pencil test, allows testing and scoring without the need for test centers or especially trained personnel. This factor allows for expansion or contraction of testing to meet the needs of the services without creating additional administrative problems.

Research should be continued to improve the effectiveness of the written aptitude test. However, it is not reasonable to expect that improvement in aptitude testing alone will bring about a significant reduction in the elimination rate. Factors other than aptitude, which may not be related to aptitude, appear to be responsible for many eliminations.

Expand the Flight Instruction Program

The second conclusion is that the Flight Instruction Program should be expanded. As presently authorized, the Flight Instruction Program (FIP) is applicable only to those officers who enter pilot training through the Reserve Officer Training Corps. United States Air Force pilot training applicants from the Officer Training School (OTS) source and U. S. Navy Aviation Officer Candidates (AOC),² should be selected through the Flight Instruction Program.

²OTS is a commissioning course for college graduates who did not participate in ROTC. AOC is similar, however, the candidates are not commissioned until they have completed flying training.

In 1963 the U. S. Air Force recorded an elimination rate of 19.7 per cent for FIP trained ROTC graduates versus 33.8 per cent for non-FIP trained ROTC graduates.³ During fiscal year 1965 the U. S. Navy eliminated 7.6 per cent of FIP trained ROTC graduates versus 30.1 per cent of non-FIP trained ROTC graduates.⁴ It should be noted that trainees from ROTC account for only forty per cent of the total annual input into U. S. Air Force pilot training. Approximately thirty-five per cent of the entries⁵ come from Officer Training School and currently, trainees from this source have the highest attrition rate of any type of student in the U. S. Air Force pilot training program--32.3 per cent.⁶

FIP training of ROTC students reduced eliminations from U. S. Air Force pilot training by 14.1 per cent (33.8%-19.7%). If eliminations of OTS trained students could be reduced by a like amount, which is a reasonable assumption, pilot training failures could be lowered from the present 32.3 per cent to 18.2 per cent. Instead of entering 148 OTS students to graduate 100 pilots, only 122 need be entered to produce 100 pilots. A pilot training program based on an annual production of 1,000 pilots from the OTS source, for example, would require 260

³Unpublished data provided by Miss Eileen Barrett, Command and Historian, HQ, Air Training Command, Randolph AFB, Texas, 27 Jan 66.

⁴Unpublished data provided by Ensign P. S. Gingrey, CNTRA Staff, NAS Pensacola, Florida. 15 Dec 65. Cited hereafter as Gingrey.

⁵U. S. Air Force Program Flying Training 67-1, 17 Feb 65, p. 1-10 (Rev.).

⁶Unpublished data provided by Capt. Charles L. Coker, Operations Staff Officer, DCS Operations, HQ., Air Training Command, Randolph AFB, Texas. 1 Feb 66.

fewer OTS entries to obtain the same pilot production rate. Each eliminated trainee completes an average of 184 flying hours before being eliminated from pilot training.⁷ Two hundred and sixty-two hours are required for the complete course. Based on the current U. S. Air Force cost of \$86,030 per pilot training graduate,⁸ the average number of hours flown before elimination, and the average cost of FIP training, the author estimates that the U. S. Air Force could save approximately \$11,600,000 per year by extending FIP training to the OTS program. To put it another way, the savings which could accrue from extending FIP training to OTS students could pay for training an additional 113 pilots per year.

The U. S. Navy flight training procurement and attrition problem is quite similar to that of the U. S. Air Force. AOC graduates, like OTS graduates, have one of the highest trainee failure rates (26.6 per cent in fiscal year 1965) of Naval student pilot sources.⁹ Expansion of FIP training to include Naval AOC graduates should produce savings in like proportion to those for OTS.

FIP screening can be expanded to include OTS and AOC applicants with a minimum of organizational and administrative changes. Many OTS and AOC applicants graduate from colleges and universities where ROTC detachments are presently operating a Flight Instruction Program. Of the 186 U. S. Air Force ROTC detachments, for example, all but twelve

⁷Ibid.

⁸Unpublished interview with Mr. Charles Niblock, Financial Analysis Branch, DCS Comptroller, HQ., Air Training Command, Randolph AFB, Texas. 25 Jan 66.

⁹Gingrey

offer FIP.¹⁰ Expansion of the FIP facilities presently operated by the services would provide adequate coverage for most of the United States. Responsibility for establishing FIP training near those population centers which do not have a convenient ROTC FIP program could be assigned to the flying activity of the nearest appropriate base, post, or naval air station.

The designated military installation's responsibility would be to provide ground school and to insure efficient operation of the training program. With the exception of ground school, which would require additional military manning or civilian contracting, training could be conducted by any responsible service unit as well as by a ROTC detachment. Each service has regulations and manuals in being which cover the establishment and operation of FIP training. Flight facilities, equipment, and instruction are provided under contract by an FAA approved flight training school, and FAA administers the flight checks.

Some OTS and AOC applicants may reside in areas where FIP training is not conveniently available. Policy covering these individuals is best left to the gaining service.

¹⁰Unpublished data provided by Mrs. Ileana A. Brown, Writer-Editor, Air Force ROTC, Air University, Maxwell AFB, Alabama.
29 Dec 65.

Congress authorized the FIP for ROTC by public law in 1956.

The program is periodically reviewed by Congress and presumably would not have been continued if it were not financially sound. The same logic ought to dictate legislation extending the FIP to OTS and the military academies, as well as ROTC. An annual review of such an expanded program would insure that it was, in fact, saving the taxpayers money.

Develop a Modern Apparatus Test

The third conclusion is that apparatus tests should be included in testing to evaluate pilot potential. Research conducted during World War II clearly established that apparatus tests can predict success in pilot training as well as written aptitude tests. It was also concluded that scores on apparatus and written tests, when combined, are more accurate predictors than the score of either type of test taken alone. Apparatus tests were discontinued, not because they were poor predictors, but "because their contribution to prediction was not sufficient to justify the considerable difficulty and expense of maintaining them in numerous examining centers."¹¹

¹¹Unpublished information provided by Dr. Robert E. Miller, Research Psychologist, 6570th Personnel Research Laboratory, Lackland AFB, Texas. 3 Feb 66.

U. S. Army apparatus testing began in 1941 with borrowed equipment, with minimum professional assistance, and without proof of a presumed relationship between psychomotor traits and success in piloting. Research in pilot applicant testing during the war was devoted primarily toward validating the tests in use and improving the reliability of testing apparatus.

It has been more than twenty years since the end of World War II; twenty years since active research on the use of apparatus testing was conducted. Post-war advances have made it possible to overcome two primary problems associated with apparatus testing--equipment reliability and the operation of test centers.

Manufacturing has benefited enormously from space-age generated technology. Precision manufacturing, made necessary by missiles, "maintainability" engineering required for modern aircraft, and the reliability of solid-state electronics can be incorporated into any new apparatus test. Appropriate specifications would make it possible for a modern apparatus to be operated and maintained by untrained personnel and still produce consistent test scores. Techniques of automatic calibration checks, simplified malfunction analysis, and printed "read-out" of information are widely used and could be incorporated. Operator and student instructions could be given by means of a taped television presentation to simplify and standardize test administration.

A modern apparatus test, properly designed, would be adaptable to current and future methods of recruiting. Tests are presently administered by recruiting or ROTC detachments as opposed to administration by test centers which was the method used during

World War II. If the previously mentioned problems of calibration, maintenance and administration are overcome by design and manufacturing improvements there is no reason why apparatus tests cannot be made available at the locations where written tests are currently being given. The apparatus tests of World War II were conducted on relatively small and simple machines. It is reasonable to assume that a modern apparatus test could likewise be small and simple. By producing the apparatus in quantity, at least one would be available in each recruiting and ROTC detachment. Additional machines could be authorized wherever required by the volume of applicants, or as desired by the respective service.

The World War II apparatus test program was oriented toward identification of those psychomotor traits which were considered necessary for piloting an aircraft. The success of the program indicates that specific psychomotor traits are important and can be identified. One might also develop the thesis that the Flight Instruction Program is, in effect, a psychomotor test, on the assumption that successfully piloting a light plane demonstrates possession of certain psychomotor traits. The success of the Flight Instruction Program in reducing eliminations tends to substantiate the requirement for psychomotor apparatus testing.

In addition to testing for psychomotor traits, the apparatus may make it possible to test for other factors which have not been evaluated to date and which do not lend themselves to evaluation by means of a written test. An individual's ability to perform under conditions of stress may be one of the primary indicators of success in pilot training and in subsequent operational flying. It may be possible to accomplish

stress testing on the same apparatus that is used for measuring psychomotor traits. One possibility would be to establish the psychomotor scores by a test or series of tests and then determine a stress tolerance score by gradually increasing the speed of the same tests until the individual's ability to perform is exceeded. Another possibility would be to introduce additional requirements or extraneous information at increasing rates and measure performance under these conditions.

Extensive research will be required in order to determine which psychomotor traits are most predictive of success in pilot training, what type of apparatus will best test for these traits, if it is possible to evaluate stress tolerance, and to determine the best method to test for stress tolerance. It is not possible to estimate the cost of such research, the cost of producing the required apparatus, or the per cent by which eliminations will be reduced as a result.

The author estimates, however, that each one per cent reduction in the U. S. Air Force elimination rate will result in an annual savings of \$1,450,000. As a basis for comparison, the entire cost of the apparatus equipment used during World War II was approximately \$250,000.¹² Manufacturing costs have risen, and more apparatus will be required now than were used during the war. On the other hand, apparatus can be expected to last for a few years, and make it possible to reduce the elimination rate by several per cent. It is reasonable to predict, therefore, that the cost of research and production would be only a fraction of the financial savings which will result from the more efficient selection system made possible by a modern apparatus test.

¹²Army Air Forces Psychology Program Research Report No. 4,
ed. Arthur W. Melton (Washington, D. C.: HQ., U. S. Army, 1947), p. 982.

Develop a Written Motivation Test

The fourth conclusion is that the military services should initiate a research project to develop a valid motivation test. There is no attempt to measure motivation in the current selection procedures and none has been attempted in the past.

Studies have indicated that measurable attitude and motivation factors exist which could make a valid motivation test possible. The ability to measure and index individual motivation for flying would unquestionably aid in selecting men who will succeed in pilot training. Motivation provides that inner "Horatio Alger" quality which assists an individual in overcoming the obstacles between himself and his objective. A valid motivation test might prove to be as accurate for predicting success in pilot training as the written aptitude test or the apparatus test, or at least a valuable adjunct to those tests.

The absence of definitive studies or examples makes it impossible to speculate on the impact that such a test would have on the rate of eliminations from pilot training. However, the potential financial savings which could be realized if such a test proved successful are considered sufficient justification for conducting a research project.

Continue Analysis and Research

Development of new apparatus and motivation tests will require an extended period of time. It is unfortunate that research of this type has not already been accomplished as part of a long range plan of research and analysis of selection methods.

As aircraft become more complex, the demands on pilots and the cost of training will increase accordingly, with a commensurate increase

in money spent training students who will not graduate. Only by employing efficient methods of selection can the military services hope to reduce these costs.

Through continuing research, the most efficient, economical and practical method of selecting men for pilot training can be determined. Research and development directed toward better selection procedures must be initiated now, and continued in the future.

SUMMARY

This chapter states and supports conclusions drawn from the discussion in Chapters I through III.

The first conclusion is that written aptitude tests should be retained in the selection method. The current elimination rate of pilot trainees is approximately twenty per cent, as compared with nearly fifty per cent before World War II. The written aptitude test, developed during the second world war and continuously improved since that time, is the only test presently used by the military services to evaluate pilot potential. Because of its reliability and ease of administration, the written aptitude test should continue to be the basis of any method of selecting pilot trainees.

The second conclusion is that the Flight Instruction Program (FIP) should be expanded. Present laws restrict FIP training to ROTC students,

thereby excluding more than half of the student pilot sources from this type of screening. Pilot training applicants from the U. S. Air Force Officer Training School (OTS) and U. S. Navy Aviation Officer Cadet (AOC) programs are major sources of entries who are not covered by this type of screening. These sources have traditionally had the highest elimination rates in their respective pilot training courses.

The U. S. Air Force experienced a reduction in eliminations from 33.8 to 19.7 per cent among ROTC students through use of the Flight Instruction Program, and the U. S. Navy has reported even better results. It is reasonable to assume that the Flight Instruction Program can reduce OTS and AOC eliminations as it has reduced ROTC eliminations. This would mean that 260 less OTS entries would be required for each 1,000 OTS source pilots graduated each year, and a corresponding \$11,600,000 annual reduction in the cost of training.

Flight Instruction Program screening can be extended to include OTS and AOC rapidly within the present administrative framework. Since many of the OTS and AOC students graduate from institutions with ROTC detachments, an expansion of existing Flight Instruction Programs should accommodate most OTS and AOC applicants. In other areas, responsibility for contracting Flight Instruction Program training

could be assigned to the nearest appropriate base, post or naval air station.

Expansion of the Flight Instruction Program will require congressional approval. Congress has annually reviewed and retained the program for ROTC since 1956. The logic which retains the Flight Instruction Program for ROTC will make it reasonable for congress to expand the program to include OTS and AOC applicants.

The third conclusion is that the apparatus tests should be included in testing to evaluate pilot potential. Extensive testing during World War II proved that apparatus tests used in conjunction with written tests provide more valid predictions of success in pilot training than either alone.

Apparatus tests were discontinued because they were difficult to maintain and inconvenient to administer from test centers, and not because they were poor predictors. The space age technology which has evolved in the twenty years since the last operational apparatus tests were developed, has made it possible to overcome all of the major problems associated with administration, maintenance and distribution of apparatus tests.

In addition to testing for psychomotor traits, the apparatus may make it possible to test for other factors. There is evidence to

indicate that an individual's inability to adjust to the stresses of flying is the primary cause of eliminations from pilot training. Stress testing is not a part of the current selection procedures, and it is questionable if a written test could be capable of measuring tolerance to stress. An apparatus test, however, may be used to determine the level of effective performance under stress by increasing test speed and introducing confusing information, and thereby contribute significantly to the efficiency of the selection method.

Extensive research will be required in order to produce valid tests and design reliable apparatus. The cost of such research and development is insignificant, however, when compared with an estimated \$1,450,000 annual savings for each one per cent reduction in eliminations from U. S. Air Force pilot training. The high cost of pilot training dictates the necessity for developing a modern apparatus test as soon as possible.

The fourth conclusion is that the military services should initiate a research project to develop a valid motivation test. There is no attempt to measure motivation in the current selection procedures and none has been attempted in the past. Studies indicate that measurable attitude and motivation factors exist which could make a valid motivation test possible. Reliable measurement of this quality, in conjunction with written and apparatus tests, offers the possibility of reducing

eliminations from pilot training to an insignificant number. Because motivation testing has such potential, research and development should begin as soon as possible.

Development of the new apparatus and motivation tests will require an extended period of time. If the military services hope to prevent the waste of millions of dollars in unproductive pilot training each year, the development of better selection procedures must be initiated now and sustained in the future.

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